The official voice of the Air Force Research Laboratory
news@afrl Features
April 2003

Researchers explore microbial hydrogen

by Timothy R. Anderl, Materials and Manufacturing Directorate

TYNDALL AIR FORCE BASE, Fla. — Researchers are developing a biological method of producing hydrogen from waste streams created by dining halls, kitchens, latrines, hospitals, laundry facilities and showers at bare base facilities.

When successful, researchers from Air Force Research Laboratory's Materials and Manufacturing Directorate will have demonstrated that hydrogen production from bare base waste streams is a feasible alternative source of energy for fuel cells. Using hydrogen as an alternative energy source is an exciting option due to its high conversion efficiency and nonpolluting nature.

Bare base facilities have as many as 1,100 military personnel who live in temporary housing. Their mission often requires the base to function for several years, with little or no services provided by the host nation. Currently, MEP-12 diesel generators produce the electrical power needs of the base.

A two-reactor system, currently being developed by researchers from ML's Weapons Systems Logistics Branch, is expected to reduce logistical burdens, pollution, and noise associated with using current diesel energy generators for energy production. Fuel cells driven by hydrogen will lower diesel fuel consumption, and minimize the use of fossil fuels for production of hydrogen.

Though hydrogen is the most abundant element on earth, it is bound to other elements and has to be separated before it can be used in energy generation. Microorganisms contain enzymes that can produce hydrogen from waste materials, providing a seemingly inexhaustible source of material for hydrogen production.

In order to fully extract the hydrogen from organic molecules, ML experts have developed a two-stage process: a fermentative reactor with a photosynthetic bacterial hydrogen production process. The photosynthetic reaction uses the energy from sunlight to completely convert organic acids to carbon dioxide and hydrogen molecules.

By using microorganisms, such as bacteria, in hydrogen production, the production process would encourage additional waste recycling, reducing waste disposal and treatment needs of nations hosting the base. Also, no additional carbon dioxide is released during this process. The process is similar to biodegrading organic molecules at a wastewater treatment facility. However, at the wastewater facility the hydrogen is not collected or used.

In the past, scientists have developed thermochemical and electrochemical methods for hydrogen generation, but these processes are energy intensive and are not always environmentally friendly. Biological methods, like the ones used by AFRL present a less energy intensive means of hydrogen production. These occur at ambient temperatures and pressures, which require very little energy and predominantly generate hydrogen and carbon dioxide.

Researchers built an up-flow fixed bed anaerobic reactor to begin testing biological hydrogen production. The reactor was filled with earth pellets that provide abundant sites for the bacteria to attach and form biofilms. A soil sample, which contained the bacteria and sucrose solution, was introduced to the earth pellets. The reactor was operated at low flow rates to allow the bacteria to colonize the earth pellets and as bacteria degraded the sucrose, carbon dioxide and hydrogen were produced.

This initial fixed bed reactor had problems channeling the flow of the sucrose solution through the pellets. To correct this, ML engineers created a fluidized bed reactor, which eliminated the channeling problem and allowed formation of a uniform biofilm. The improved reactor consistently produced 60 to 80 percent hydrogen. Future studies conducted by the group will include operation of a reactor that replaces sucrose with actual airbase wastewater as the carbon and energy source.

continued on page 2

continued on page 2

The information gained from operation of the bench scale reactor will be necessary to assess the hydrogen available in bare base waste streams, and determine whether adoption of this process is cost-effective. Success of the project will expand opportunities to develop the process as an alternative energy source for other industrial operations. @